

S Y L L A B U S, 4

OF

CHEMICAL AND PHILOSOPHICAL
ENQUIRIES,

Composed for the Use

OF THE

NOBLEMEN and GENTLEMEN

Who have subscribed to the PROPOSALS
made, for the Advancement of

NATURAL KNOWLEDGE,

By B. HIGGINS, M. D.

L O N D O N :

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LONDON MEDICAL SOCIETY

ADVERTISEMENT.

THE following Proposals, altho' formerly published, are inserted with a view to express the purposes for which the approaching meetings are to be held.

DOCTOR HIGGINS of *Greek Street, Soho*, encouraged by the Literary NOBLEMEN and GENTLEMEN, who have subscribed to his Courses of philosophic and practical Chemistry, addresses the following Proposals to the patrons of Natural Philosophy and useful Arts.

P R O P. I.

That fifty philosophic and literary Gentlemen do concur in promoting experimental enquiries into the Elements of Matter and Laws of Nature, and such other subjects as are most important in Natural Philosophy, Chemistry and Arts:

II.

That until better measures can be devised and agreed on, the Plan, offered in these Proposals, be adopted:

III.

That, as the Elaboratory of DOCTOR HIGGINS is already provided with a considerable apparatus, and several necessary accommodations for the abovementioned purposes

poses ; and as he hath manifested a disposition and attention which recommend him on this occasion, his Elaboratory shall be the place wherein these enquiries shall be made, and he shall conduct the experiments :

IV.

That a Subscription be immediately opened by DOCTOR HIGGINS for the purposes expressed in the foregoing and the subsequent Proposals : That each Subscriber do contribute ten guineas : That the Gentlemen who are desirous to subscribe do give the earliest notice thereof to DOCTOR HIGGINS ; and that the Subscription be closed when fifty Gentlemen shall have subscribed :

V.

That the first general meeting of the Subscribers be on *Monday* the 13th of *November* 1775, at seven o'clock in the afternoon, in the Elaboratory abovementioned ; and that they be, every other day, for three months thereafter, at an hour to be appointed by the Subscribers at the first meeting :

VI.

That previous to these meetings, DOCTOR HIGGINS do appropriate an hour every day, from ten to eleven o'clock in the forenoon, to hear the sentiments and receive the instructions of the Subscribers—the month of *July* only excepted :

That

VII.

That DOCTOR HIGGINS shall precisely at the hours to be appointed, open each of these meetings with a Discourse in the Didactic Form: That in these Discourses he shall introduce the Natural Phenomena, the illustrative observations and experiments of Philosophers, Chemists and Artists; and particularly his notions and experiments concerning the Primary Elements and the Properties of Matter.

That by bringing into one view what hath been hitherto discovered, together with a considerable number of such new and conclusive experiments on these subjects, as he hath devised, and as shall be maturely devised by the Subscribers, he shall endeavour to improve the former, or establish better, doctrines:

VIII.

That every thing to be advanced by him on these occasions, shall be supported by observations and experiments to be made in a conspicuous manner before the Subscribers, or by producing the apparatus and result of such experiments as require much time, and must necessarily be made during the intervals of the meetings:

That

IX.

That each Introductory Discourse shall not exceed half an hour; unless protracted by very interesting experiments; and that afterwards the time be employed by the Subscribers in communicating, objecting, proposing or devising whatever may be thought conducive to the purposes already expressed :

X.

That the Subscribers be at all times admitted to see and direct the operations and experiments :

XI.

That minutes be taken of the proceedings, recording all that shall be meritoriously suggested or done by each Subscriber; and that these minutes be the property of the Subscribers :

XII.

That assisted and advised by the learned Gentlemen who have already subscribed, and those who will please to subscribe in due time, DOCTOR HIGGINS shall exert himself during the Summer and Autumn previous to the proposed meetings, in preparing and arranging the matter of the intended Introductory Discourses; in forming a Syllabus for the use of the Subscribers; in devising instruments and experiments, and making
an

an addition to his present apparatus, suitable to the occasion and the abovementioned liberal subscription :

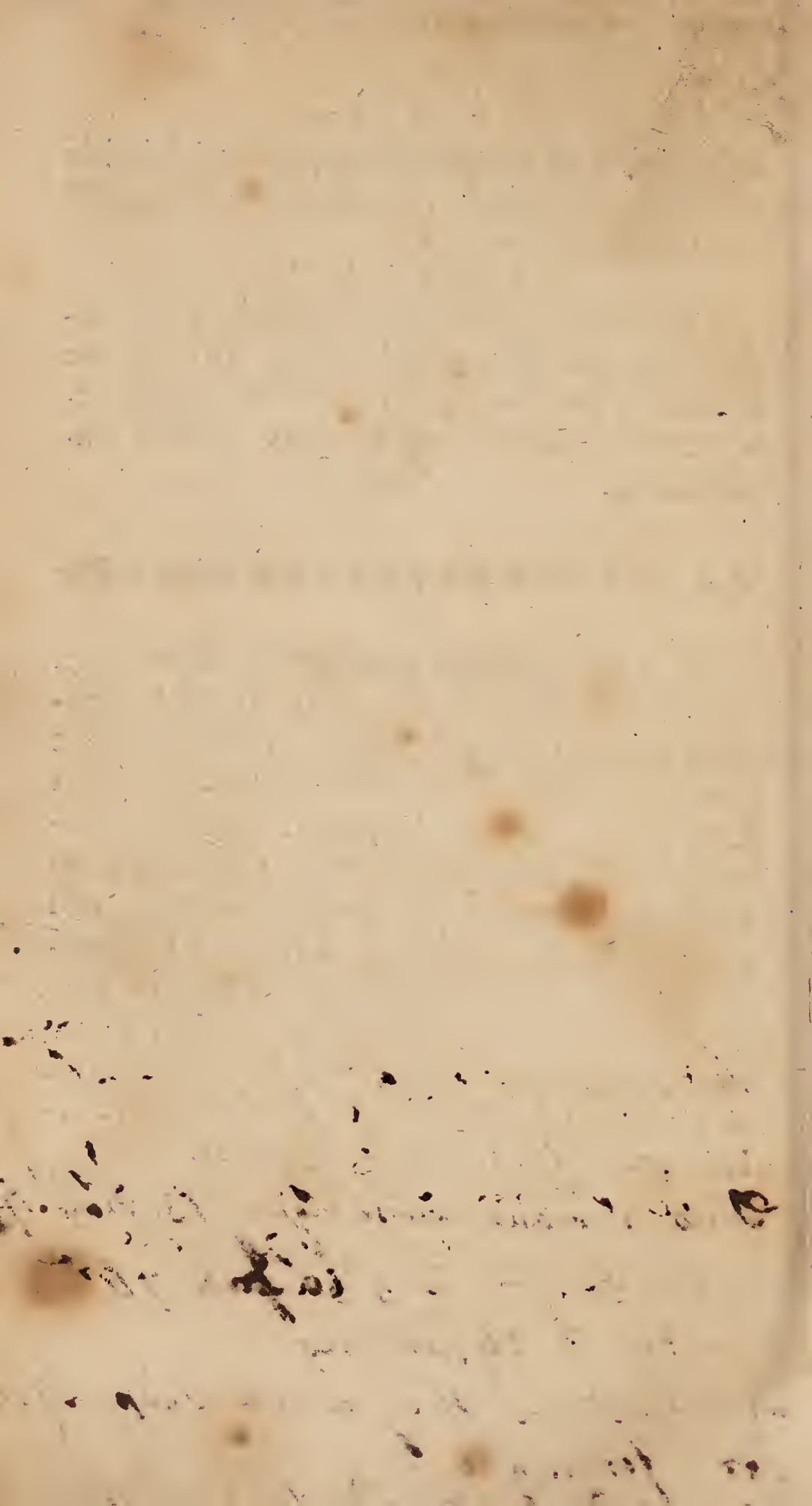
FINAL L Y.

That DOCTOR HIGGINS shall be accountable for the subscribed sums, in case he should be prevented, by sickness, or otherwise, from performing his part in this undertaking.



As a considerable number of Gentlemen have lately subscribed, who, though eminent in other departments of science, think themselves not sufficiently acquainted with Chemistry ; Doctor Higgins, in order to enable each subscriber more effectually to promote the views of these meetings, will give a *Previous Course* of Practical Chemistry, in which the didactic order will be preserved. In this preparatory course, many interesting experiments, will be introduced in a manner subservient to the researches alluded to in the following Syllabus.

*This previous course began, 13. Nov. 76
 & ended on the B 3 30 Jan, 76
 it contained 29 lectures —
 at Christmas they were suspended
 for a fortnight —
 Lecture-days. Mond. Wed, & Friday's
 at 2 in the evening*



The discourses were begun
on the 5 Feb, 1776

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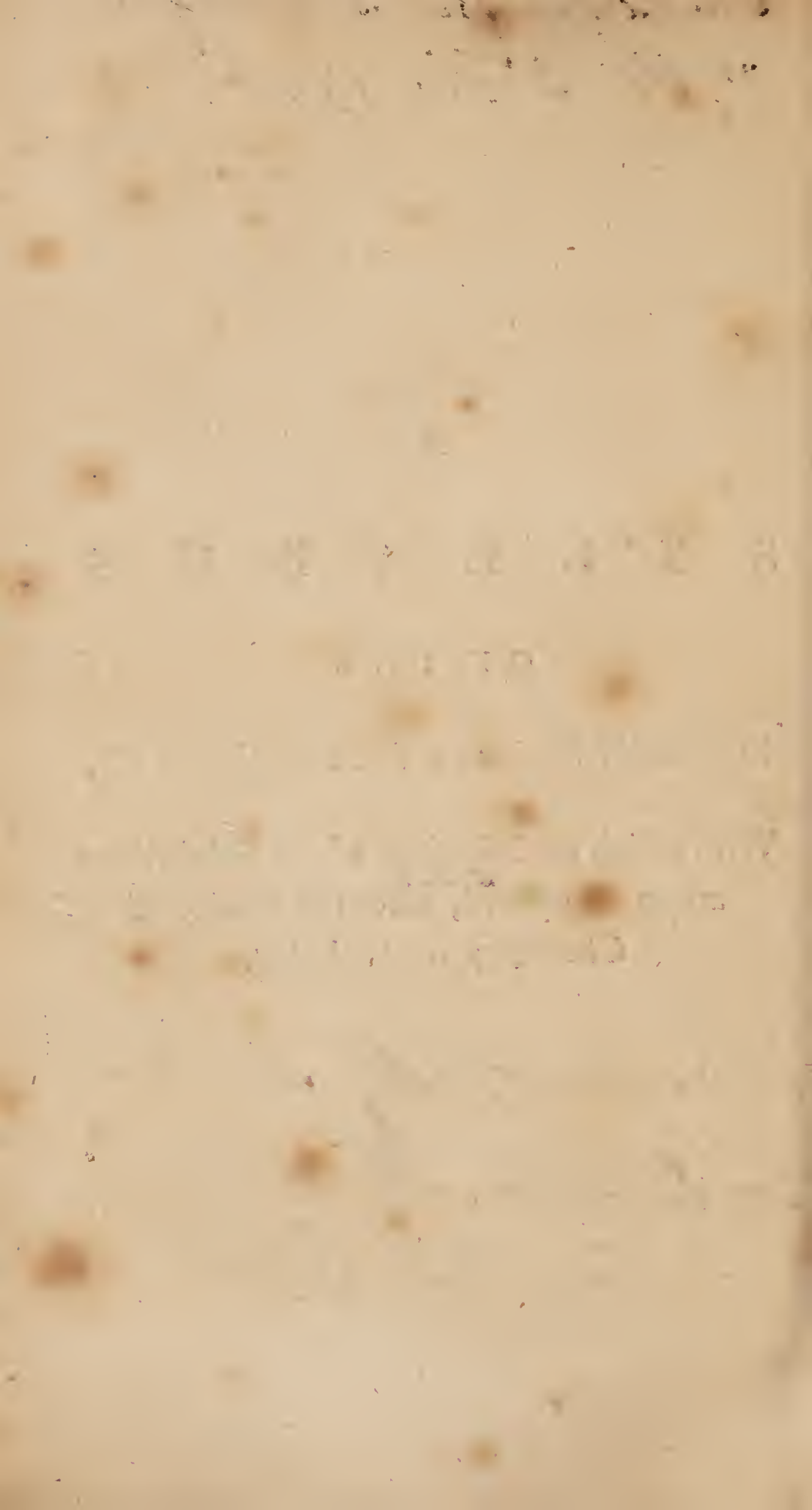
S Y L L A B U S

O F T H E

DISCOURSES AND EXPERIMENTS,

With which the Meetings of the Subscribers
are to be opened, ^{5 Feb} after the Course of
Chemistry is concluded,

Respectfully presented
to John Masses Esq.
by the Author



INTRODUCATORY - discourse on matter in general, called gross matter; on the varieties and distinctions of gross matter; on the primary elements of matter.

Observations on the experiments and phenomena exhibited in the foregoing course of chemistry, and other experiments which demonstrate the existence of seven primary distinct elements of matter, *viz.*

Earth,	Air,
Water,	Phlogiston,
Alkali,	Light,
Acid,	

Experiments, observations, and arguments, shewing upon what grounds, fire, the ethereal fluid of modern philosophers, and the mercurial principle of the chemists, are to be rejected from the class of primary elements.

Experiments, observations, and arguments, persuading that each primary element consists of atoms homogeneous; that these atoms are impenetrable, immutable in figure, inconvertible, and that in the ordinary course of nature they are not annihilated, nor newly created.

Observations and experiments, persuading, that the atoms of each element are globular, or nearly so; and that the spiral, spicular, and

and other figures ascribed to these atoms, are fictions unnecessary, and are inconsistent with the uniformity and simplicity of nature, and repugnant to experience.

Practical applications of these doctrines ; diagrams constructed in consequence thereof, and observations on the uses and importance of diagrams in the ensuing researches.

Observations illustrated by experiments of our sense of the foregoing seven elements, separately ; of our sense of the union of two or more of the foregoing elements. Experiments and observations, shewing, that the possible and known unions of the foregoing elements ; and that the possible and known proportions, in which the unions, of the foregoing elements may take place, are more numerous than the bodies distinguished by philosophers or naturalists ; persuading, that all known bodies are really composed of one or more of the foregoing elements ; and that all bodies must be admitted to consist of these only, until other elementary matter is found necessary for the explication of the natural phænomena, and is demonstrated to exist.

A classical arrangement on the table of bodies, composed of two or three primary elements ; which bodies, in various chemical processes, not being decomposed, we call
chemical

chemical elements, or the elements of the chemists.

A like classical arrangement of bodies composed of two chemical elements.

A like classical arrangement of bodies and natural substances composed of many chemical elements.

Remarks on the foregoing bodies, with a view to inculcate such general knowledge of them as will facilitate the future investigation of the elements and properties of matter, &c.

Examination of the doctrines of authors, who admit various kinds of attraction, as so many distinct laws of nature; of others who ascribe attraction and repulsion to the agency of an ethereal repellent fluid; and of others who attribute the attraction of bodies to the operation of an intermediate matter or cementing principle.

Review of experiments made in the preceding course of practical chemistry, and observations authorizing the proposal of the following opinions and the phrases briefly expressing them, with a view to facilitate the ensuing investigations.

OPINION,

1. That the homogeneous atoms of five elements repel reciprocally.

2. That

2. That the homogeneal atoms of two elements attract reciprocally.

3. That the dissimilar atoms of five elements attract reciprocally.

4. That the dissimilar atoms of two elements repel reciprocally.

5. That the attraction subsisting between elementary atoms, is more forcible in one direction or axis of each atom, than in any other direction; and that there is a polarity in all matter whatever.

6. That there is but one species of attraction operating with great force between the similar or dissimilar atoms of certain elements; and with less force between those of other elements, in gradations, but in all affected by distance and polarity.

7. That the attractions of bodies enumerated as distinct properties of matter or laws of nature, are nothing more than the sums of the attractions of their elementary atoms; or these forces counteracted in a certain degree by the presence of repellent atoms, or these forces exerted to the greatest advantage in bodies whose primary elementary attractions are strongest, and whose primary elementary atoms, are also arranged in polar order.

8. That specific gravity is not as the quantity of matter in a given space, but as the
the

the quality of the matter, or the sum of its elementary attractions. Consequently that light bodies are not necessarily more porous than the heaviest.

Observations on the phenomena presented in the practical course of chemistry, and authorizing the following positions concerning fire: viz.

1. That fire pervades all known bodies.
2. That fire expands all known bodies.
3. That fire produces effects on bodies diametrically opposed to the power and effects of attraction.—That it counteracts and in effect, weakens, balances, or overpowers the force of attraction.
4. That positions concerning the universal effects of fire, but extending no further, and equally consistent with nature and the doctrines of philosophers, may be inserted in any part of a system of natural philosophy, antecedent to the investigation of the cause of these effects.

Of the Earthy Element, and Bodies consisting of this Matter chiefly.

The metalizable earths, the unmetallic earths, and compound earthy bodies arranged on the table.

Observations and experiments, shewing that near six hundred distinctions of earthy

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bodies;

bodies, made by naturalists, altho' useful in arts, are to be rejected in chemical philosophy, inasmuch as these varieties are produced in many by the mode of aggregation only, and in others by heterogeneous admixture, or combination.

Observations and experiments, shewing the grounds on which we ought for a while, to admit the following distinctions of earths, viz.

Seven earths, capable of forming ductile metals.

Seven earths, capable of forming metals not ductile,

Seven earths, incapable of forming metal.

Question 1. Is there but one earthy element, which in various modes of aggregation, or in indissoluble combination with other elementary matter, forms twenty-one earthy bodies; or, *Quest. 2.* Are there three times seven, or seven times seven, earthy elements.

The affirmative of the first question urged by experiments, observations and arguments.

The negative of the first question urged by observations and arguments.

Probable conclusions.

New experiments with a view to decide on the foregoing questions.

Propositions concerning the method to be observed in the ensuing inquiries; and arguments

arguments persuading that if we confine ourselves to the consideration of properties common to all earthy bodies, our future reasoning will not be erroneous, whether there be, only one, or many earthy elements.

Illustrative diagrams, exhibiting the circumstances in which we may, without inconvenience, use the word earthy element, for the future; and the circumstances in which we may occasionally attend to the chemical classes of earthy bodies, yet avoid contradiction or error.

Experiments and observations shewing that the earthy elementary atoms, attract the atoms of other elements; and arguments persuading that these attractions are not to be further considered in this place, but reserved until the other elements come under examination.

Experiments and observations, shewing that the homogeneous atoms of earth, attract each other.

Experimental and geometrical estimation, of the force of this attraction in fortuitous arrangement of the atoms, and of the force of this attraction in the polar arrangement of the atoms.

Experimental and geometrical estimation of this attraction in contact, compared with its force at given distances.

Review.

Review of the phenomena exhibited in the practical course of chemistry, which authorize the anticipation of doctrines hereafter demonstrated, *viz.* The doctrine of the repulsion of the homogeneal atoms of all elements except earth and water; of the forcible attraction of earthy atoms to each other; of the force with which they attract other elements; of the quantity of earthy matter, and the sums of the attractions of earth to earth and other matter. Inductions that earth ought to gravitate more than any other known matter, and as it doth gravitate agreeable to the premises, that the gravitation of earth is not a distinct law of nature, but the sum of the forces of the elementary attraction of earth to earth and other matter.

The attraction causing aggregation and gravitation of earth considered in opposition to the action of fire. General observations on fixity, expansibility, fusibility, fluidity, volatility, evaporation; the fixity of earths, rationally, and experimentally deduced from the foregoing properties of this element; fixity being an effect of attraction, and not admissible as a law of nature.

The other properties of this element, and the conclusions further deducible from these
already

already recited, are to be subjects of future consideration.

Of the Element of water.

Of distilled rain, river, spring, and mineral waters, and their impregnations.

The experiments of Boyle, Borrichius, Wallerius, Leidenfrost, Margraaff, Eller, and Lavoisier, considered, and the conclusive experiments repeated; together with new experiments, proving water to be an elementary matter incapable of decomposition; that the pretended conversion of water to earth is an erroneous notion, and that there is but one aqueous element.

Observations and experiments, persuading that the purest known state of the watery element, is that of ice, and that ice becomes fluid by the interposition of fire, or aerial, or acid, or other matters, demonstrable one or more in all fluid water, and expelled or drawn away in freezing.

Various phenomena of freezing natural and artificial, exhibited and explained.

Observations and experiments, shewing, that the indestructible immutable atoms of water do attract each other: shewing further

The ratio of this attraction in contact of the atoms, and at given distances ;

And shewing that this attraction is less forcible than the atomary attraction of homogeneous earthy atoms ;

And that the atoms of water have polarity.

Observations and experiments, proving that water and earth reciprocally attract each other.

Observations on capillary attraction, Introsusception, wetting, &c.

Estimation of the attractions subsisting between the atoms of water, and between water and earth and other matter, and of the relative quantities of these matters.

Inductions that the gravitation of water corresponds with the sum of the elementary attractions, and that gravitation is not, in water, a primary law of nature.

Experiments, shewing that bodies of the greatest specific gravity, (as gold, &c.) when finely divided will float on water, or remain suspended in it wherever they are placed.

Inductions from the premises explaining these phenomena, and many others, particularly the phenomena of bubbles, drops and streams of water, of the formation, of spars, ores, &c. And shewing why many
bodies

bodies are formed in water and works effected in the lapse of time, which no art can extemporaneously accomplish.

Reasons why the phenomena of water, with inflammable and other bodies, are not yet to be introduced.

Experiments, demonstrating the effects of fire on water in all the varieties induced by pressure, whether by the altitude of the column, or by air, vapour, &c. and experiments, &c. relative to the *balneum mariæ*, *balneum vaporis*, Papin's digester, water sustaining red heat, evaporation, distillation, condensation, ebullition in air, and in vacuo, explosions of water; and the circumstances in which this element is palpable or only visible, or totally invisible.

Explanations of these phenomena, according to the premised properties of water and the known effects of fire.

Of the Alkaline element.

Chemical history of alkaline substances, in the order in which they stand on the table.

Experiments, shewing the insufficiency of the vulgar tests of alkaline substances; that alkali doth exist in all bodies from which it is by any means obtainable; that it is not the *creature of fire*, as the chemists imagine; that

that it is only extricated by fire, as other matters are from compound bodies. Inductions, that fire severs bodies, but neither creates nor destroys matter.

Observations and experiments, shewing that all the alkaline substances of the chemists, are compound bodies. And that the caustic volatile alkali is that which is least compounded.

Experiments, shewing the alkaline matter solitary, and demonstrating this to be an elementary matter, altho' not hitherto known or noticed as such, and that there is but one elementary alkali.

Observations and experiments, shewing that the atoms of alkaline element repel each other; and shewing the ratio of this repulsion at given distances, and that by reason of this repulsion varied by distance, this element is an elastic, compressible, expandible, invifible fluid.

Experiments shewing the atomary repulsion of this element, counterpoised by the attraction of other matter, and the formation of fluids of greater density or less volume, but yet invifible: And next, the atomary repulsion of alkaline element overpowered by the attraction of other matter to its atoms, which are thus approximated sufficiently

ficiently to form a palpable fluid: And lastly, the atomary repulsion of alkaline element so much overpowered by the attraction of other interposed matter, that solid ponderous masses are formed therewith.

The cementing principle, alkaline air, and other conceits of the like nature, considered.

The true causes of ebullition, intumescence, effervescence, and of the incoercible vapours of the chemists, considered; and practical advantages resulting from this knowledge, experimentally demonstrated.

Experiments and calculations ascertaining the distance to which the repulsion between the atoms of alkali can be extended, with a force equal to the whole pressure of the atmosphere: The force of this repulsion also considered at smaller and greater distances.

Probable suggestions that repulsion and attraction, which are forcible in contact, less forcible but yet mensurable at various distances, do universally extend to distances indefinite, altho' not perceptible to our imperfect organs of sense.

Inductions, explaining the conditions in which matter is invisible, visible, fluid, solid, compressible like air, or incompressible; and experiments shewing, that alkali, like other matter, reduced to a state in which it eludes

eludes vulgar observation, and in which it hath been supposed to be lost or commuted, is nevertheless identical, incommutable, indestructible.

That attraction and repulsion being indefeasible properties of alkaline and other matter, suffer no suspensions, fits, or interruptions, and never are commuted in any circumstance or distance, but only balance or overpower one the other, and thus occasionally seem to be weakened or destroyed.

General observations on the elasticity of fluids and of solid bodies.

Experiments shewing, that repulsion is the cause of the former elasticity and attraction the cause of the latter.

Inductions concerning fluidity, softness, hardness, plasticity, ductility, brittleness, applied to earth, water, alkali, and compounds of them, and equally applicable to other elements and compounds.

Experiments to determine whether the alkaline element conveys sound, which it is presumed it will do.

Observations and experiments shewing the polarity of the alkaline element, and the difference of the aggregations formed by fortuitous arrangement, from those formed by

by polar arrangement of this elementary matter in combination.

Saturation considered in the manner of the schools.

The true cause of saturation investigated.

Experiments, shewing that no element doth saturate, nor can saturate the like element; that no element, whose atoms attract each other, can saturate any other element whose atoms attract each other; that a repellent element doth saturate non-repellent elements, and *vice versa*; that repellent elements do saturate reciprocally; and that attraction and repulsion, operating adversely are the cause of saturation; and saturation is not a distinct or primary law of nature, but an effect.

Experiments and diagrams, explaining the phenomena of invifible fluids formed by two or more elements which attract and saturate each other; the phenomena of vifible or aqueous fluids formed by two or more elements which attract and saturate each other; and the phenomena of folid maffes formed by two or more elements which attract and saturate each other; demonstrating the caufes of thefe phenomena, and of all the conditions of faturated elastic fluids, faturated incompressible fluids, and faturated folid bodies, and the other conditions

tions of saturated matter intermediate between these.

Experiments, shewing the various new appearances and properties different from those of the pure elements, induced by saturation; and experiments and diagrams, demonstrating that saturation must necessarily induce such new appearances and properties, without the assistance of any laws of nature except those of attraction and repulsion; and consequently that all the visible varieties of compound bodies, and their distinguishing properties, the *tertium quid* of the chemists, &c. &c. depend on the properties attributed above to the seven primary elements.

Experiments, shewing that elementary alkali attracts earth.

Estimations experimental of the force of this attraction in contact, and at given distances, in fortuitous, and in polar arrangement of the atoms.

Experiments, shewing that alkaline element attracts water.

Experimental estimations of the force of this attraction in contact, and at given distances.

Experiments, shewing the levity or weak specific gravitation of the alkaline element; the sum of its attractions compared with those of earth and water; the sum of its repulsions

pulsions considered. The force with which it ought to gravitate, according to the premises, estimated; and being found to correspond with the real gravitation of this element; the gravitation of alkali is to be held as the excess of the foregoing attractions above the sum of the repulsions, and not as a primary law of nature.

Reasons why the action of fire on alkali, and various phenomena of alkali in combination, are reserved for future consideration.

Of Acids in general.

The chemical history and distinctions of acids, in the order in which they stand on the table.

Observations and experiments shewing, that all the acids of the chemists are compound bodies.

The question concerning the identity of the acid element stated.

Observations, experiments and arguments
Pro.

Observations, experiments and arguments
Contra.

The arguments *pro* and *contra* weighed; new experiments, and all experiments proposed in the minute-book, to be made with a view to decide the foregoing question.

D

Probable,

Probable conclusions, that the acid element exists in the vitriolic and marine acids in a state nearest to purity; and that from these, together with the nitrous and acetous acid, the characters of acids are to be drawn.

A method proposed, and to be observed on the part of the author, whereby the future investigations shall not be interrupted, and the future doctrines shall not be erroneous, whether there be one or many acid elements; which method is the same as is observed with respect to earth. See Earth.

Experiments shewing, that acid matter is not commuted or destroyed, in any combustions or detonations, or other processes, whereby it is lost to the chemists, and thence supposed to be destroyed: And also, that it is not generated in efflorescences, putrefactions, fermentations, &c. but only disengaged, or attracted from contiguous bodies.

Observations and experiments, shewing the acid matter solitary or pure, or nearly so, and demonstrating that it is an elementary matter, altho' not heretofore known or noticed as such.

Observations and experiments, shewing that the atoms of acid element repel each other;

ther ; and shewing the ratio of this repulsion at given distances ; and that by reason of this repulsion, varied by distance, this element is an elastic, compressible, expansible, invisible fluid.

Experiments shewing the atomary repulsion of acid element counterpoised by the attraction of other matter, and the formation of fluids of greater density, but yet invisible ; And next, the atomary repulsion of acid element overpowered by the attraction of other interposed matter to the acid atoms, which are thus approximated sufficiently to form an aqueous fluid ; and lastly, the atomary repulsion of acid element so much overpowered by the attraction of other interposed matter, that solid ponderous masses are formed therewith.

Conceits of acid air, vitriolic air, acetous air, nitrous air, &c. corrected. The true causes of ebullition, intumescence, effervescence ; and the useful application of this knowledge in practice, exhibited.

Experiments and calculations, ascertaining the distance, to which the repulsion between the atoms of acid can be extended with a force equal to the pressure of the atmosphere. The force of this repulsion further considered at greater and smaller distances.

Experiments and observations authorizing positions equally applicable to acid and the foregoing elements ; and suggesting that repulsion and attraction, which are forcible in contact, less forcible but yet mensurable at various distances, do extend to distances indefinite, altho' not perceptible to our imperfect organs of sense.

Experiments and inductions, explaining the conditions in which acid, like other matter, is invisible, visible, fluid, solid, compressible, incompressible ; and persuading that acid, like other matter, reduced to a state in which it eludes vulgar observation, is nevertheless identical, incommutable, indestructible : And that attraction and repulsion being indefeasible properties of acid as well as of other matter, suffer no suspensions, fits or intermissions, and never are commuted in any circumstance or distance, but only balance or overpower one the other, and thus occasionally seem to be destroyed, or not to exist.

Observations and experiments on the acid element and acid compounds, and inductions confirming the foregoing doctrines concerning elasticity, fluidity, softness, hardness, plasticity, ductility, brittleness.

Experiments to determine whether the acid element conveys sound,

Ob-

Observations and experiments, shewing the polarity of the acid element, and the difference of the aggregations formed by fortuitous arrangement, from those formed by polar arrangement, of this elementary matter in combination.

Observations and experiments on the acid element and acid compounds, and inductions generalizing and confirming the foregoing doctrines concerning saturation, its causes, and extensive effects in nature.

Experiments, shewing that elementary acid attracts earth; and experimental estimations of the force of this attraction in contact, and at given distances, in arrangement fortuitous, and arrangement polar.

Diagrams, explaining various phenomena, which at first view seem repugnant to the foregoing doctrines.

Experiments, shewing that acid element attracts water: Experimental estimations of the force of this attraction in contact, and at given distances.

Experiments, shewing that acid element attracts alkali.

Experimental estimation of the force of this attraction in contact, and at given distances.

The incompetency and errors of the tables of elective attractions demonstrated; and

comprehensive tables commenced, in which the blanks are to be filled up as fast as experiment will authorise.

The sum of the attractions and repulsions of acid element considered; and the gravitation of acid deduced from the foregoing attractions, as an effect, and excluded as above-mentioned from the list of primary laws of nature.

The former doctrines concerning fixity, volatility, specific gravity, generalized and confirmed.

Of Air.

Review of the pneumatic experiments, and doctrines which are unexceptionable, and ought to be assumed on the present occasion.

Experiments and observations shewing that atmospheric air contains various matters different from the aerial element; shewing the difficulty of obtaining any considerable quantity of pure air; the errors into which experimental philosophers have been led, by the impurities of atmospheric air; and the methods whereby these and other errors may be in future avoided.

Experiments and observations, shewing that the atoms of air repel reciprocally; and estimations of the force of this repulsion, in
con-

contact and at various distances of the aerial atoms.

Experiments, shewing the atomary repulsion of air balanced by the attraction of air to other interposed matter, and the consequent formation of an elastic invifible fluid of greater density than air hath, in like circumstances of atmofpheric or mechanical preffure; And shewing the atomary repulsion of air overpowered by the attraction of air to other interposed matter, and the consequent formation of an incompressible, vifible, palpable fluid; and laftly shewing the atomary repulsion of air, fo much overpowered by the attraction of air to other interposed matter, that incompressible, palpable, folid ponderous maffes are formed thereby.

Inductions from the premifed experiments, importing that the atoms of air, however approximated, combined, or detached from compounds, are never commuted or destroyed; that there is but one aerial element; that the elementary repulsion of air, which causes elasticity, being a law of nature, is never fufpended, but only counteracted; that the elasticity of air cannot be impaired by mechanical force as hath been fupposed; that air is not indefinitely compressible; that the volume to which a
por-

portion of atmosphoric air can possibly be reduced by mechanical force, may be truly estimated; and that neither air nor any other known matter attracts at one distance and repels at another distance; but that air and all known matters attract at every distance those bodies which they attract at any distance, and repel at every distance those bodies which they repel at any distance.

Remarks on the pneumatic electrical and other experiments, which have led philosophers into notions repugnant to the foregoing.

Observations on the imperfections of the air pump and other pneumatic machines, and on the advantages and disadvantages of our apparatus.

Experiments and observations, shewing that pure air repels earth.

Experiments and observations, shewing that air doth attract water.

The phenomena of evaporation, exsiccation, hygrometers, deliquiation, humidity, sweating walls, and water distilled from air; the phenomena which have suggested the notion of the conversion of mercury and various other bodies into water, &c. &c. deduced from the premises.

Esti-

Estimation of the force of this attraction in contact, and at various distances of the atoms of air and water.

Question. Doth pure air attract pure alkali, or repel alkali; or neither attract nor repel alkali; which latter may be called neutrality.

Reasons why neutrality ought to be rejected; and why, as the affirmative of the question implies attraction, the negative implies repulsion.

Experiments, in order to * decide on the question.

Whatever may be the event of these experiments, it may be remarked, that neither attraction nor repulsion of air to alkali is assumed in any part of the following doctrines; that in pursuing nature we ought rather to leap over small obstacles than lose sight of nature by waiting to remove them; and that it is better to pass the attraction or repulsion of air to alkali, unnoticed, than to expend much time on a subject of no great importance, or to admit a dubious position.

Experiments and observations, shewing that air doth attract acid, and shewing the pro-

pro-

* It is presumed that a repulsion between air and alkali will be demonstrated.

properties of the bodies formed by this combination.

The theory of saturation further confirmed.

Experiments in order to analyse the nitrous acid compleatly.

Comparisons of the attractions and repulsions of air, and of the quantity of matter which attracts air, with the quantity of matter which repels air; and inferences shewing the gravitation of air is the effect of the foregoing elementary attractions, &c. and not a primary law of nature.

Application of the premised experiments and doctrines, concerning air and the preceding elements, towards explaining the motions, impulse, and vibrations of air, our sense of which is expressed by the words blast, crack, sound, tones; towards the illustration and confirmation of the foregoing theories of visibilty, invisibility of matter, and of saturation, and of fluidity, solidity, elasticity, &c. and towards explaining the agency of air, in the processes which we express by the words tarnishing, rusting, mouldering, corruption, rotting.

Review of the experiments which gave rise to the opinion that the atoms of air are larger than those of water.

The

The phenomena of these experiments, and particularly the free passage of water thro' bodies which are not pervious to air, deduced and explained from the premises.

Phlogiston.

Recital of experiments, observations, and arguments, representing the imperfections of our sensitive organs, and the necessity of employing our rational faculties in order to assist and correct common perception, in the investigation of elements much more subtile than the foregoing, as pervading all instruments and vessels.

Combustion and ignition experimentally distinguished; definition of these words.

Experiments demonstrating that none of the foregoing elements, nor of the bodies composed of them, are combustible, altho' they may be ignited or charged with fire.

Experiments demonstrating that all the foregoing elements (except water) and all compounds of these elements, can be charged with another matter so as to become combustible.

A classical arrangement on the table of earthy, acid, alkaline, aerial bodies, and combinations of these, charged, in the ordinary

dinary processes of nature, with matter which renders them combustible.

Experiments, shewing the same bodies artificially charged with a matter which renders them combustible, and that both nature and artificial compounds containing this matter, are in the act of combustion deprived of it; and that after this privation they are not combustible.

Reasons why the combustible bodies are called phlogistic bodies, and why the matter whereby they are rendered combustible, is properly called phlogiston.

Comparisons of the foregoing elements and compound bodies consisting of them, with the like elements and compound bodies charged with phlogiston; and experiments, shewing that altho' combustibility is a proof of the presence of phlogiston; incombustibility of bodies is not a proof that they contain no phlogiston, but only that they retain it by the more forcible attractions.

Experiments and observations, demonstrating that the phlogistic matter in ethers, spirits, oils, balsams, resins, gums, mucilages, vegetables, charcoal; in all animal substances; in petrolia, amber, asphaltum, mineral-coal, and all combustible mineral bodies; in all ores, and metals, and in all known bodies; is transferable to other non-phlogistic

phlogistic bodies, and from any one body to another, in certain gradations directly or in any series by artificial means; forming new compounds with all bodies except water; and that this matter after having undergone numerous transfers, combinations, exposures to fire, &c. ultimately forms with acid, alkali, earth, air, the compounds formed by these in native combination with phlogiston, or by these in any artificial combination with the phlogiston of any body.

Observations on the foregoing experiments, and other experiments shewing, that phlogiston is a matter subtil, elastic, invisible, incommutable, indestructible, incapable of decomposition, differing remarkably from those already mentioned; that phlogiston is a distinct element; and that there is but one phlogistic element.

Observations on the experiments on phlogistic bodies, and fresh experiments shewing, that as phlogiston, in passing from these bodies, or when detached in these experiments, passes through the vessels and eludes common observation; the combinations in which it is rendered visible or palpable, are to be well examined, previous to the further consideration of this elementary matter; that the eye of reason may co-operate with common perception, in the investigation of the

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properties where-with the phlogistic element is endued.

Experiments, demonstrating that phlogiston doth attract air ; that this attraction is one of the agents in combustion ; that air and phlogiston saturate each other, and that the compound of phlogiston and air hath properties different from those of the component elements. Experiments exhibiting these new properties ; and diagrams shewing they are the necessary effects of the attraction of phlogiston to air balanced by the repulsion subsisting between the similar atoms of these elements, agreeable to the doctrine of saturation already established.

Experiments shewing that the atoms of phlogiston and air, are approximated by their mutual attractions to each other, inso-much that both phlogiston and air occupy less space when mixed, than either occupies when pure, under any given pressure atmospheric or mechanical ; and that the compound of phlogiston and air is, in like circumstances of atmospheric pressure, a denser fluid than air, and is specifically heavier than atmospheric air.

Inductions from the premises, and diagrams explaining why, phlogiston and air which attract each other, do not form a mass ;
and

and why they form an invisible, expansible compressible fluid.

Experiments shewing, that air saturated with phlogiston, is incapable of attracting phlogiston.

Inductions from the premises, and diagrams, shewing this to be the necessary effect of saturation; and that by reason of saturation, phlogisticated air doth not assist or maintain combustion.

Experiments shewing that phlogisticated air combines with bodies which attract either phlogiston or air, and consequently combines with bodies which do not attract pure air or pure phlogiston.

Inductions and diagrams, shewing this latter property of phlogisticated air to be the necessary consequence and effect of the laws of nature already demonstrated.

Experiments, shewing that phlogisticated air, which is an elastic invisible fluid, not greatly exceeding pure air in specific gravity, forms with other invisible elastic fluids which attract it strongly, ponderous, visible, palpable masses. These phenomena deduced from the premises.

Experiments, shewing that phlogisticated air is transferable without decomposition, from one body to another, and that the number of these transfers already discovered, is

is very great; and that the phenomena attending them, correspond with, and confirm the foregoing doctrines.

Experiments, shewing various other properties of phlogisticated air, its fatal effects on animals, its effects on the electric matter, &c.

Recapitulation of the foregoing properties of phlogisticated air, *viz.* the specific gravity, compressibility, expansibility, invisibility, incapacity to maintain combustion; the effects in combinations; the gradations of its attractions to other bodies; the circumstances in which it is formed; the processes in which it is detached; the circumstances in which it is transferred; the effects of it on animals, on the electric fluid, &c. All shewing, that phlogisticated air is the same matter which modern philosophers call *fixable air*.

Experiments synthetic, shewing that phlogisticated air, or fixable air, is always composed wherever and however pure phlogiston is mixed with pure air.

Observations on the experiments in which fixable air is formed, shewing air to be necessary and phlogiston necessary, for the formation of fixable air; and that no matter, except phlogiston, and air, and light, is present
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in every experiment in which fixable air is formed.

Conclusions from the premises, importing, that fixable air may, by heterogeneous admixture, assume various appearances; but that fixable air is a compound of phlogiston and air only.

Inferences concerning the fixable air from solutions, ignitions, combustions, fermentations, animal digestion, respiration; and concerning damps of the miners, and noxious subterranean cavities. The varieties observed in fixable air formed in various circumstances accounted for; and applications of this knowledge to practice, in experimental and trading chemistry, and in the imitation of mineral waters.

Experiments analytic, shewing that phlogisticated air may be decomposed; that it is decomposed by the means and in the circumstances necessary for the decomposition of other phlogistic bodies; that this decomposition is a process daily performed by nature; that air and phlogiston are discovered in all these decompositions, and no other matter whatever; that the air severed from phlogiston, has all the properties of atmospheric air, and none of those peculiar to fixable air; that the phlogiston thus severed from air, hath all the properties of phlogis-

ton, and none of those peculiar to fixable air: conclusions that fixable air is a compound, and consists of phlogiston and air, and of nothing more.

Observations on the uses of fixable air, and the circulation of it in nature; until it is decomposed, and its constituent air is diffused in the atmosphere or else-where; and its constituent phlogiston is lodged in bodies, or contributes to the growth, mass and combustibility of vegetables.

Estimation of the force wherewith phlogiston attracts air.

Experiments and observations, shewing that phlogiston attracts alkali; and exhibiting the phenomena of this combination: the phenomena explained according to the theory of saturation.

Estimation of the force of this attraction, in contact and at various distances of the atoms.

Experiments and observations, shewing that phlogiston doth attract acid; that these saturate each other; that the compound of phlogiston and acid hath properties different from those of the component elements; and that these properties correspond with the doctrines already advanced concerning attraction, repulsion and saturation, and tend to establish them; in a much as
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in natural philosophy we can have no stronger proof of the truth of any doctrine, than its consonance with the natural phenomena.

Experiments shewing, that the atoms of acid are approximated by phlogistic atoms interposed, and that nevertheless phlogiston and elementary acid do not form a solid mass, or palpable fluid, but only an elastic invisible fluid.

Inductions from the premises, and diagrams, explaining why the compound of phlogiston and acid doth assume the foregoing form or condition, and no other.

Experiments, shewing the combustibility of this invisible compound of acid and phlogiston; and that this compound, like other phlogistic bodies, requires the concurrence of air and fire towards its combustion. The various phenomena of the combustions of this invisible fluid explained, according to the premised laws of matter.

Recapitulation of the demonstrated properties of the combination of acid and phlogiston, shewing that this is the matter which modern philosophers call INFLAMMABLE-AIR.

Experiments synthetic, shewing that inflammable air is composed, whenever pure phlo-

phlogiston is presented to acid pure, or nearly pure; but that the compound acid matter, called nitrous acid, is not only unfit for this purpose, but prevents the formation of inflammable air in all circumstances yet discovered.

Observations on the experiments in which inflammable air is composed, or is detached from bodies by fire; and observations on the places and circumstances in which it is found native; all shewing, that acid and phlogiston are necessary to the formation of inflammable air; and that no matter, except phlogiston, acid and light, is common to all, or present in all these experiments and places, in which inflammable-air is formed.

Observations, on the inflammable air detached or formed in solutions, decompositions, fermentations, putrefactions, vitrifications, ignitions; in distillations of microcosmic salt with phlogistic matter, in distillations of oils, æthers, and various phlogistic compounds: observations on native inflammable air, fire damp, &c; all shewing, that inflammable air, by reason of heterogeneous admixture, doth assume various appearances; but that inflammable air is a compound of acid and air.

Appli-

Applications of these doctrines, concerning inflammable air, to chemical practice, and to the art of composing artificial mineral waters.

Experiments shewing that inflammable air may be decomposed, and that it is decomposed in the ordinary course of nature.

Conclusions from the analytic as well as the synthetic experiments, importing that inflammable air consists of phlogiston and acid, and of nothing more.

Observations on the circulations of inflammable air, and the continuance of these circulations, until its acid is drawn away by other matter, and its phlogiston is attracted by non-phlogistic bodies, to form phlogistic combinations, or to contribute to the mass and combustibility of vegetables.

Experiments and observations shewing that phlogiston attracts earth.

Estimation of the force of this attraction in contact and at given distances of the atoms.

Comparative estimation of the attraction of phlogiston to earth, to alkali, acid, and air.

Digression concerning alchemistic enquiries; vindication of alchemists, and cautions against the dangers of alchemy.

Exami-

Examination of the opinions concerning Fire, and particularly the opinion prevalent with modern philosophers, who suppose that Fire is a certain motion of matter.

Confutations of these opinions.

Experiments and observations, shewing that Fire is a matter different from any matter treated of previous to phlogiston; and that motion is not necessary to the existence of fire.

Experiments and observations shewing, that the attraction of phlogiston to the foregoing elements, or bodies composed of them, is counteracted, or in effect weakened, by fire; and particularly that the attraction of phlogiston to air, is counteracted, or in effect weakened, by the introduction of fire.

Experiments and observations, shewing that pure phlogiston doth not attract pure water, and is not combinable with water, except by means of some matter interposed, which attracts both phlogiston and water; but that phlogiston nevertheless easily pervades water.

Inductions from the premises, explaining how repellent elements are combined by means of a third element; and how compounds which will not unite, are by means of a third compound united; and how bodies, which will not cohere, are, by means of

of a third body, made to cohere; and explaining various other phenomena, which may be ranked under the following heads, *viz.* Intermediums, cements, wetting, scouring, inflammable bodies soluble in water, inflammable bodies not soluble in water.

Experiments and observations, shewing that the atoms of phlogiston attract other atoms more forcibly in one axis of each atom than in any other; or, that phlogiston like other elementary matter hath polarity.

Experiments, shewing that many non-phlogistic bodies, accurately weighed, and then combined with considerable quantities of phlogiston, acquire no additional absolute gravity by this access or addition of phlogiston.

Other experiments shewing, that the absolute gravity of many non-phlogistic bodies, is considerably counteracted or in effect lessened by combining these bodies with phlogiston; and shewing, that these bodies, whose absolute gravity hath been lessened in the foregoing manner, acquire or resume a greater absolute gravity, when they are deprived of phlogiston, than they had whilst they retained the phlogiston: inferences from these experiments, persuading that phlogiston doth not gravitate, and that it hath a power whereby it counteracts the gravitation of other matter.

Esti.

Estimations of the attractions of phlogiston; of the repulsions of phlogiston; of the relative quantities of different elementary matters in the terraqueous globe which attract phlogiston, and of the quantities of matter in the terraqueous globe which repels phlogiston.

Conclusions, implying that the sum of the repulsions of phlogiston, exceed the sum of the attractions; and consequently, that if gravitation be an effect, and not a primary law of nature, as hath been advanced, phlogiston ought not to gravitate; and since it is experimentally found not to gravitate; that the foregoing theory of gravitation is further confirmed.

The levity and volitility of æthers, spirits, oils and various inflammable bodies, and other phenomena, of a similar nature, occurring in the practice of chemistry, in arts, and in the great elaboratory of nature, deduced from the premises.

Comparisons of the specific gravity of phlogistic bodies with that of other bodies: arguments in addition to those already used, persuading, that specific gravity and density are not commutable terms, as the most celebrated philosophers have assumed and used them; that there is not necessarily more matter in a cubic inch of glass than in a cubic inch of resin; nor larger pores or
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interstices in the resin than in the glass; altho' the specific gravity of glass be much greater than that of resin; and finally that gravity depends as much on the species of the gravitating matters, as on the quantity of them.

Experiments and observations, shewing, that phlogiston, when detached in saturations, fermentations, decompositions, native vitriolizations; in combustions, culinary, chemical, phosphoric; in collisions frictions, &c. is either Fire, or is a constituent elementary ingredient of Fire.

Experiments and observations, shewing, that phlogiston, whether in combination, or detached, is *not* fire; that fire, whether in bodies, or parted from them, is not phlogiston; and that fire differs from phlogiston, as much as any known compound differs from its component elements.

Inductions, implying that since phlogiston is not fire, but is a constituent ingredient of fire, fire is a compound body consisting of phlogiston and some other matter.

Enumeration of the former experiments, which shew that the bodies formed with phlogiston, and the elements and compounds hitherto examined, are totally different from fire; and enumerations of the demonstrated properties of all the elements

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and compounds, treated of previous to phlogiston ; shewing, none of these can be an ingredient or component part of fire.

Inductions, persuading, that as fire is a compound, containing none of the foregoing elements, except the phlogiston now under consideration ; and as we know no other element, saving light, wherewith phlogiston can form a compound possessing the properties of fire ; we may reasonably presume that fire is composed of phlogiston and light, and of no other matter whatever.

A digression concerning light, with demonstrations of the properties of that element which relate to the present subject.



Read the first twenty paragraphs on Light.



Experiments and observations, shewing, that fire hath properties different from those of phlogiston, and from those of light, and corresponding with the doctrine of saturation ; that the general properties of fire, are intermediate between those of phlogiston and light, in the same manner as the general
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properties of other compound bodies are intermediate between those of their component elements ; and that we are led, by general analogy, to consider fire, as a compound of phlogiston and light.

The arguments *a priori*, and the arguments from analogy ; supported by arguments *ex absurdo*, persuading that fire is composed of phlogiston and light.

The foregoing assertion further supported on the following grounds :

That it is presumed to correspond with the natural phenomena ; that nothing will appear repugnant to it in our future experiments ; that by admitting it, we shall explain appearances which are otherwise inexplicable ; and be enabled to prognosticate the result of many new experiments.

Reasons for not introducing these tests in this place ; and why these tests, wherever introduced, render the foregoing assertion as credible as any other assertion admitted in natural philosophy..

Observations and Experiments shewing, that phlogiston doth attract light ; that these elements saturate each other ; and that it is possible truly to estimate the force of this attraction, in the same manner as the attraction of other elements hath been estimated.

Experi-

Experiments on combustion, shewing the circumstances necessary thereto.

EXPERIMENTS.

First, On bodies, which, for their combustion require no ignition: *secondly*, on bodies, which, for their combustion, require nearly the quantity of ignition given by a flint-spark: *thirdly*, on bodies, which, for their combustion, require nearly the quantity of ignition given by tinder: *fourthly*, on bodies which, for their combustion, require nearly the quantity of ignition given by the blaze of a taper: *fifthly*, on bodies, which, for their combustion, require the several intermediate degrees of heat, between those of the taper and of the fiercest furnaces.

Experiments exhibiting the combustions which are extremely slow, and are accompanied with no perceptible heat: experiments exhibiting the combustions which are quicker, in their progress, than the foregoing, and are accompanied with various degrees of heat: experiments exhibiting the combustions which are rapid in their progress, and are accompanied with intense heat: all at the same time, exhibiting the agency of air in combustion; the inefficacy of phlogisticated air; and the retardation of combustion, by every means whereby the air meets impediment, or undergoes alteration.

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Experiments, shewing that some phlogistic bodies, may, by the gradual application of fire, be sooner evaporated than inflamed, even in the presence of air; but may sooner be inflamed than evaporated, by any other application of fire, in concurrence with air; and further shewing that such bodies consist of repellent elements, are weakly aggregated, gravitate weakly, and are easily volatilized by fire.

Experiments, exhibiting detonations and explosions; commencing with those of small force and slow progress; and proceeding thro' numerous gradations, to those which are instantaneous and forcible in the highest degree; exhibiting also the elementary matters concerned in these explosions, and the manner in which they operate on each other, to cause explosion, and various other phenomena.

Experiments and observations, on burning lamps, candles, flam-beaux, &c. The combustions of oils, tallow, spermaceti, wax, &c. compared. Observations on the use of wicks. Observations on the commencement and progress of these combustions. Observations on the extinctions and revivals of these combustions, by currents of air and other means.

Observations on the phenomena accompanying the formation of burrs or snuffs, and various positions of wicks.

Observations on the effect of snuffing candles.

Experiments, exhibiting the phenomena of combustions checked by water or succulence, and of combustions extinguished by water, fixable air, and other fluids.

Experiments exhibiting the unextinguishable combustions.

All the foregoing phenomena of combustion, detonation, explosion, explained; and shewed to be the necessary result of the various kinds, and of the specific properties of matter already mentioned; confirming the preceding doctrines, and particularly that of fire.

Experiments and inductions, shewing that the intensity of fire, is in the direct ratio of the quantity of fire composed or retained in any given space, in every instant of any given time; And that every degree of fire or heat, from that which we call temperature, up to the furnace heat, hath the like relation to time and space.

Experiments and inductions shewing that blaze differs from fire, in its properties and in its composition: and shewing that blaze is a *mixture* of fire and phlogistic matter which hath not yet formed fire.

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Experiments exhibiting various phenomena of smoak, foot, and the residuary matter of combustions.

Inductions from these experiments, and observations on combustion, fire, blaze, smoak, foot and residuary matter; confirming the foregoing doctrines, and useful or explanatory in arts.

Inductions from the foregoing experiments, importing, that air is not a necessary ingredient in fire; that it is not a *pabulum ignis*, as philosophers have imagined; and that it is no otherwise necessary in combustion, than as an agent, in the extrication of phlogiston, from the other matter of combustible bodies.

Experiments shewing the different effects of furnaces differently constructed; how furnace heats, greatly exceeding those heretofore known, may be excited; how fire may, most equably and conveniently, be applied to large masses of matter, and to great distances; how to manage fuel to the greatest advantage; and how to make choice of fuel for various purposes.

Theory of the draught of chimnies, of the construction of furnaces, kilns and fire-places; and theory of the other subjects of the last paragraph; founded on the premised experiments and properties of matter.

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The management, uses and effects of the blow-pipe, shewed and explained.

Experiments and observations pointing out improved methods of burning smoak; of extinguishing accidental fires in certain circumstances; of curing smoaky chimneys, however ill constructed, by alterations in the stoves only; and pointing out improvements in arts which require the application of fire.

Experiments and observations shewing that fire is an elastic fluid; that this elasticity is a necessary effect of the demonstrated properties of phlogiston and light; and that the power which causeth this elasticity, is repulsion; which hath been demonstrated to be the cause of elasticity in other fluids.

The theory of saturation introduced, and digrams presented, in order to shew more clearly, why light, which attracts phlogiston, doth not form therewith a solid mass, or dense fluid, but only an elastic fluid.

Review of the experiments which shewed the subtilty of phlogiston and of light; and inductions importing that the capacity, which fire hath to pervade all bodies, is the necessary result of the demonstrated properties of the compotent elements of fire; and that from this property of fire, no exception ariseth

aristeth against the doctrine of saturation ; in as much as that doctrine doth not teach that the size of elementary atoms can be altered, nor that molicules can be formed until the atoms are in contact.

Inductions from the properties of light and phlogiston, and from various experiments and observations on fire; importing, that fire is capable of receiving and communicating motion.

Experiments and observations shewing, that bodies whose elementary atoms are held in contact by the more forcible attractions, are least expanded by a given charge of fire ; that fluids whose atoms are approximated by the less forcible attractions, are most expanded by the like charge of fire ; and that solids, or fluids, whose atoms are closely approximated, or held in contact by attraction intermediate between the foregoing, in force, are expanded to degrees intermediate between the foregoing, by the like charge of fire.

Experiments and observations shewing, that solid bodies, which are expanded by a small charge of fire, are softened by a greater charge of fire ; are rendered fluid or fused by a charge of fire still greater ; and are thrown into vapour, by a charge of fire much greater than the foregoing charges.

Experiments,

Experiments and observations shewing, that fluids, are expanded by a small charge of fire; are thrown into vapour expanding with some force, by a greater charge of fire; and that this vapour is made to expand with much greater force, by much greater charges of fire, than the foregoing.

Theory of the Thermometer.

Considerations of the foregoing experiments and observations:—Consideration that fire cannot expand or destroy attraction, which is a law of nature:—Consideration that attraction is most forcible in contact, and decreases in some regular inverse ratio of the distance of the atoms:—Inductions from these experiments, observations, and facts considered; importing, that fire has the power of counteracting attraction, by reason of its capacity to remove contiguous atoms of bodies to a distance from each other. Inductions in like manner importing, that hardness, softness, fluidity, and the vaporous state, to which bodies are reduced by fire, are effects; the first, of powerful attraction in contact of the atoms; the second, of attraction counterpoised; the third, of attraction weakened by distance; the fourth, of attraction weakened very much by reason of the greater distances of the atoms.

Expe-

Experiments shewing, that fire, applied contiguous to a body, and not confined by that body; but on the contrary left at liberty to expand and diffuse itself on all sides, except on the coast of that body; will nevertheless expand that body, however solid and tenacious it may be. Comparison of these things, with the assertions, *that fire is matter, and that it is an elastic fluid.*

Questions arising from the foregoing experiments and assertions, viz.

Why doth not fire flow off on the side where it finds least resistance?

Why doth fire, which is at liberty to flow off on all sides, except one, nevertheless enter a solid body, and expand it, in despite of the forcible attraction whereby the atoms of that solid body resist separation?

These questions answered consistently with the premises.

Inductions explaining how fire severs the atoms of bodies from each other; how it expands, softens, fuses, and vaporizes bodies.

Considerations on various occurrences in chemistry and arts, suggesting, that the force of fire, in expanding bodies, is not indefinite. Experiments in order to examine the truth of the suggestion.

Obser-

Observations on the use and abuse of the word heat; and shewing, that it expresses only our sense of certain *effects* of fire; and that if *latent effect*, or *latent sense*, are expressions contradictory and unphilosophic; the phrase *latent heat*, conveys no clear ideas, and ought never to be used in chemistry or natural philosophy.

Experiments and observations shewing, that heat, or degrees of heat, are as the quantity of fire in a given body or space.

Review, of the experiments and natural processes, in which phlogiston is detached and doth not form fire; and of the experiments and natural processes, in which phlogiston is detached and doth form fire.

Observations on the times, distances, and circumstances, in which the effects of fire do cease; and on the transfers and privations of fire.

Inductions importing that cold, is privation of fire; and further, that the powers, whereby phlogiston, detached from combustible bodies, is prevented from forming fire; may effect the decomposition of fire.

Experiments and observations, pursuant to the foregoing inductions, persuading, that fire is actually decomposed, in various artificial and natural processes; and that
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this decomposition of fire, is one of the causes, whereby cold is produced.

Experiments shewing, that, when a body is suddenly expanded, by reason of its own elasticity, or by any power except that of fire; then cold is produced in that body, and in the vicinity of it.

Experiments shewing, that when any body is suddenly contracted in its dimensions, so far as to occupy a space much smaller than it did in its former state; then heat is produced in that body and in the vicinity of it.

These and all known productions, of heat and cold, explained, and deduced from the premises.

Inductions, importing, that heat is produced, in two ways: *first*, by the formation of fire; and *secondly*, by compacting the fire, which was diffused in a voluminous body, into a small body or space. Inductions importing, that cold also is produced, in two ways: *first*, by the decomposition of fire; *secondly*, by causing the fire, which was contained in a small compass, to expand into a large compass.

Experiments and observations on the circulations of phlogiston; from the compound called fire, to the bodies in which it is lodged, therewith forming inorganic combusti-

ble bodies ; and from the compound called fire, until it contributes to the vegetation and mass of combustible vegetables.

Enumeration of various natural and artificial operations, and of phenomena, which have not been noticed sufficiently in the preceding investigations : Reasons why these subjects may be now considered, in any order ; and why they may be proposed in the form of questions ; in order to shew, that the answers to these questions must be founded on the foregoing doctrines, and no others ; and consequently that these answers confirm the premises ; inasmuch as the credibility of all doctrines in natural philosophy, is founded on their correspondence with, and explication of, the natural phenomena.

Questions.

Why is there no encrease of heat in the terraqueous globe or in the vicinity of it ; in consequence of the quantity of fire hourly formed, in the course of many thousand years ?

Why is there no apparent waste of this our globe ; and why is there no deficiency of phlogistic matter ; in consequence of the waste of phlogistic bodies in burning, and
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of the vast quantities of phlogistic matter hourly formed into fire ?

Why are the higher regions of the atmosphere, colder than the lower regions ; altho' fire is evidently buoyant in air ?

Why doth the heat of combustions not extend, in open quiescent air, to any considerable distance, either horizontally or vertically : and why the heat of combustions doth not extend to any great distance, even with the wind ?

Why fire may, without notable waste, be carried to a great distance from burning bodies, by means of chimnies and tubes of massive construction : and why fire is carried from burning bodies, to the distance of many miles, in subterraneous cavities, without notable waste ?

What is the cause of meteors, fire balls, and luminous mists ?

Why doth fire affect an equilibrium in bodies and space ; and why doth it appear to have no *notable* appetence or attraction to any one mass of matter, above any other ?

What is the cause of condensation ?

Why doth a receiver, capable of containing only a quart of water, serve to condense as much vapour, in a given time ; as can be condensed in a receiver capable of holding one hundred quarts or more ?

Why

Why are heavy bodies carried away by fire, in a direction contrary to that of their gravitation; or in any direction from the focus of the fire?

Why doth fire decompose compound bodies; and effect combinations, and decompositions, otherwise not feasible; and often contrary to the order of attraction.

Why bodies, which resist the volatilizing power of fire, with extreme force, are easily volatilized, by fire, when they are combined with phlogiston?

Why do water, spirits, and other bodies, when vaporized by fire, mount in atmospheric air: and why do they mount to a certain height in the atmosphere of air, and no further?

What is the cause of wind, monsoons, hail, snow?

What are the causes of fermentation, putrefaction, decay, efflorescence, intestine motion and effervescence?

What is the cause of the putrefaction of wood, &c.

Why are putrid bodies odorous. And why are many bodies not odorous until they are struck, rubbed, or heated?

Why are putrescent bodies, long preserved from putrefaction, by fixable air?

Why is wood long preserved from rotting, by immersion in water?

What

What is the condition of air, when it accelerates putrefaction?

Why is the air in cities, woods, marshes, close prisons, and ships, less salubrious than the atmospheric air in other places?

Why is air which hath been respired, insalubrious to animals which immediately breathe it?

What is the power, whereby potential caustics destroy the human fabrick, &c. &c.

Light.

Review of the experiments and doctrines of Sir Isaac Newton and other philosophers, concerning Light. Vindication of Sir Isaac Newton, from erroneous opinions ascribed to him, in consequence of his *Queries*.

Various fallacies and inconsistencies of the modern theory of optics demonstrated.

Experiments and observations persuading that light is an elementary matter consisting of atoms of the smallest size : That light is not an emanation, or a matter sent forth by the sun, or stars, or planets, or satellites : That light exists in all bodies and spaces to the utmost limits of the known creation : That light visible, or illumination, is the element of light impressing our organs of sight sensibly : That darkness is not the absence

sence of light, or any privation of light.

That darkness is only a word, expressing our insensibility of the presence of light: that the quiescence of light is the cause of darkness; or in other words, darkness is light at rest, or in a condition incapable of making a sensible impression on our organs.

That illumination (commonly called light) and darkness, are with respect to light, what sound and stillness are with respect to air.

Observations on the errors induced in optical reasoning, by confounding the ideas of illumination, and light; by using the word light indiscriminately to express the element, and our sense of its motion; by the like improper use of the words darkness and shade. Experiments and observations concerning shade, shewing what it really is, and the impropriety of denying the ubiquity of light, because illumination, vulgarly called light, doth not bend into the shade.

Experiments and observations, shewing that light is an element consisting of atoms which repel each other; and that by reason of this repulsion, together with the subtilty already mentioned, it becomes an elastic fluid, capable of pervading all bodies, and itself invisible, altho' the medium of vision.

Expe-

Experiments and observations, shewing that light doth not attract earth or earthy compounds, water or watry compounds, alkali or alkaline compounds, acid or acid compounds, air or aerial compounds, nor compounds consisting of two or more of the foregoing, nor any compound formed with the foregoing and phlogiston; nor any known visible matter, nor any known invisible fluid, or matter, except phlogiston; but that, on the contrary, light repels all these bodies, and every known matter except phlogiston.

Estimations of the repulsions of light, of the attraction of light to phlogiston, of the relative quantities and conditions of matter attracting and matter repelling light; conclusions that light ought not to gravitate to our earth, if gravitation be only the sum of elementary attractions, or the excess of the attractions above the repulsions, as hath been suggested.

- Experiments and observations, shewing that light doth not gravitate; and why it is equably diffused in bodies and in space. Conclusions confirming the foregoing theory of gravitation.

Experiments and observations, shewing that we have no sense of illumination, or of objects by vision (or in the vulgar phrase
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we cannot see light) except when light is actuated by some matter in motion ; and further shewing, that only one species of elementary matter is capable of thus actuating light ; and that this matter is phlogiston ; and that phlogiston combined with any matter except light, hath not this property during the combination ; but that pure phlogiston and phlogiston combined with light, that is fire, have this property ; and have it only whilst they are in a state of vibratory motion.

Enumeration of the foregoing experiments, and other experiments and observations shewing, that light is not moved rapidly and progressively in the ordinary course of nature, or when it impresses us with visual sense of objects ; that no progressive motion of light is necessary to vision : but that vibratory motion of light is necessary to vision : that this motion is communicated to light by other matter whose motion is vibratory : that light affects the eye by communicated impulse, as air affects the ear by impulse, and not by progressive motion : and that light hath no laws of motion except what are common to all elastic fluids.

Review of the several experiments, observations and doctrines, which incline us to reject the opinion, that the sun is a mass of
luminous

luminous or fiery matter, or that he can emit from his substance the light or heat perceived when he is present, and yet suffer no waste or change; and which incline us to presume that the sun is a mass of matter, not unlike our earth, containing much phlogiston; and a great part of whose surface is at once burning, and whose fire is decomposed; and whose phlogiston returns to parts of his mass formerly burnt, and whose substance is consequently never diminished; and whose fire altho' it doth not pass away from his atmosphere, actuates light to great distances, as our small fires upon earth do to smaller distances, or as they would probably do to greater distances if viewed vertically thro' the atmosphere, instead of being viewed thro' the turbid air near the earth.

Inductions from the demonstrated properties of water, air, alkali, acid, phlogiston, and light; shewing why impulse communicated to all gravitating matter, whether in the form of solid masses, or invisible fluids; is to our senses lost in a small time and space; and hath, within the space, in which it is perceptible, slow successive communication or progress; and why impulse communicated to light is communicated thro' this fluid almost instantaneously to distances unmeasured; and why it is communicated thro' pure air
nearly

nearly as well as thro' spaces void of air; thro' some bodies, nearly as well as thro' air; and thro' other bodies, not in any degree sensible to our organs.

Experiments exhibiting the following phenomena and analogies which for the present are expressed by the customary terms to avoid prolixity, viz.

The phenomena of reflected light, and reflectors perfect and imperfect; of the angle of reflection; and of paralel, diverging, and converging light; and of foci of light by reflection. The analogy between these and sound, and eccho, and bodies causing iterations and increase of sound.

The phenomena of transmitted light; of bodies diaphanous perfectly, or imperfectly; of transmitted light, diverging, paralel, and converging; of foci of transmitted light. The analogy between these and sound communicated thro' bodies. The phenomena, which suggested the notions of fits of easy reflection and fits of easy transmission, and other fits of light imagined by philosophers. The phenomena of bodies opaque perfectly, or imperfectly; and the analogy of these with perfect and imperfect media of sound.

The phenomena of foci of light acting on bodies; of the cold focus of the moon, &c. —

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The foregoing phenomena explained and deduced from the premised properties of light and other matter ; all other properties attributed to light, rejected.

The phenomena of the refractions and reflections of light resumed : comparisons of the refracting power of phlogistic bodies, with that of non-phlogistic bodies ; and the reflecting power of non-phlogistic bodies compared with that of phlogistic bodies. The opacity and blackness, of certain phlogistic bodies, and their incapacity to reflect light so powerfully as others do ; and the capacity of diaphanous phlogistic bodies to refract light more than other bodies do, exhibited.

Explanations of these phenomena deduced from the premised properties of light, phlogiston and other matter.

Experiments exhibiting the phenomena of prismatic colours, and colours by refractions various ; and of colours of bodies ; and colours induced, changed, and apparently destroyed in bodies.

Review explanatory of the mechanical doctrine of communicated motion ; and percussion of elastic bodies ; of oblique planes, &c.

The foregoing colours, changes of colour, and destructions of colour, explained, and deduced from the premised properties.

perties of light and other matter. Conclusions that no other properties of light ought to be admitted.

The received doctrine of colours opposed by experiments : and observations on these and the preceding experiments, persuading, that light doth not consist of rays differing in their original properties, and impressing us with a sense of colour peculiar to each different ray ; but that our sense of colour is, our preception of the *modifications* of the vibratory motion of light ; and that the seven prismatic colours are, with respect to light, what the seven tones are with respect to air.

Experiments exhibiting the preparation and phenomena of all the known phosphori ; the glow worm and some other animals, fish and rotten wood being ranked in this class. The phenomena of phosphori explained and deduced from the premised properties of light and other matter ; or efforts made to this effect.

Considerations on the circulations of light, explaining why there is no encrease or decrease of the quantity of light ; and suggesting satisfactory answers to various questions concerning sun light, moon light, candle light, optical instruments, &c.

Review

Review of the experiments and processes, in which heat or fire is produced by mixtures, condensations, fermentations, putrefactions, friction, percussion.

Review of the experiments exhibiting the various modifications of luciferous and igneous matter, from the torrid focus of sun light, to furnace fires, blazes, warmth, down to the phosphoric cold luciferous matter, and moon light; review of the properties of phlogiston and its circulation in our atmosphere and terraqueous globe; and review of the bodies which become odorous by friction percussion and heat; introductory to the experiments presenting the phenomena of the electrical matter.

The following question proposed :

Doth the electrical fluid contain phlogiston?

Observations on the materials and circumstances necessary for exciting, accumulating, retaining, and conducting the electric matter: and summary view of all the phenomena and arguments, which incline us to believe, that the electrical fluid contains phlogiston.

Summary view of the observations and arguments, which seem repugnant to the foregoing opinion concerning electrical matter. Attempts to reconcile these with the

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affirmative observations and arguments; and to establish the opinion that phlogiston is a constituent elementary part of the electrical matter.

Experiments and observations, made with a view to discover, whether *the electrical matter is phlogiston solitary and pure, or phlogiston combined*: or whether the electrical matter is an elementary matter different from all those heretofore mentioned.

Summary view of the foregoing observations and doctrines concerning attraction.

Observations on the several species of attraction adopted by philosophers, and expressed by the words

Attraction of gravitation,
Attraction of aggregation,
Attraction of cohesion,
Attraction of intermediums,
Elective attraction,
Double elective attraction,
Capillary attraction,
Magnetic attraction,
Electrical attraction.

These several attractions illustrated by experiments, and explained, and deduced from the demonstrated attraction of the elementary atoms.

Queries and speculations concerning the animal economy and rational faculties of man;

man ; of the queries the following are a specimen :

Quer. Is it not possible for men to arrive to a perfect knowledge of all properties of matter hitherto mentioned, and to discover the cause of all the phenomena hitherto mentioned or implied ; except the few suggested in the next question.

Quer. Is it possible for men to comprehend, or reason truly on, the properties of matter or laws of nature, or divine dispensations, whereby they are enabled to live and reason.

Quer. It is possible for the mind of man to investigate the cause of vital heat, muscular motion, and sensation ; or to discover what is the nervous influence ; what is that life, which a vapour, an electric spark, or a bodkin can detatch or destroy.

Why is fixable air or phlogisticated air, which extinguishes blaze and conducts electric matter, deleterious to animals which breathe it.

Why do æthers, spiritus rectoris, vinous spirits, the vegetables called narcotic, the vegetable animal and mineral substances called antispasmodies, affect our spirits and senses ; and why is the most inflammable or phlogistic part of all these, when separated from

from the other parts, the most powerfully narcotic or antispasmodic or exhilarant?

Why doth the electrical fluid give us sense of cold, on the coast where it is excited.

Why doth air, of a certain temperature, according to the thermometer, give us sense of cold, much greater, than is given by air of the like temperature, according to the thermometer, in other conditions of the atmosphere. Or in other words; what is the cause, that we are chilled by air, which the thermometer denoteth not to be so cold as air, otherwise conditioned, in which we are not chilled.

Apology for the imperfections and errors of this Syllabus, and the improvident use of positive expressions in dubious doctrines.

F I N I S.